APPENDIX A

QUAL2E User Manual*,**

The following sections illustrate the coding of input data forms for the QUAL2E model.

A. Title Data

All 16 cards are required in the order shown. The first two are title cards, and columns 22 through 80 may be used to describe the basin, date of simulation, etc. Title cards 3 through 15 require either a "YES" or "NO" in columns 10 through 12 and are right justified. Note that each of the nitrogen and phosphorus series must be simulated as a group.

For each conservative substance (up to three) and the arbitrary non-conservative, the constituent name must be entered in columns 49 through 52. Corresponding input data units are entered in columns 57 through 60 (e.g., mg/L).

QUAL2E simulates ultimate BOD in the general case. If the user wishes to use 5-day BOD for input and output, the program will internally make the conversions to ultimate BOD. This conversion is based upon first order kinetics and a decay rate that can be specified by the user (Type 1 Data, line 8). If no value is specified, the program uses a default value of 0.23 per day, base e. It is recommended that users work only with ultimate BOD unless they have detailed knowledge of the river water and point source BOD kinetics. To use the 5-day BOD input/output option, write "5-DAY BIOCHEMICAL OXYGEN DEMAND" on the title 7 card beginning in column 22.

Card 16 must read ENDTITLE beginning in column 1.

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*From: Modifications to the QUAL-2 Water Quality Model and User Manual for QUAL-2E Version 2.2. National Council of the Paper Industry for Air and Stream Improvement, Inc., New York, NY. NCASI Tech. Bulletin No. 457. April 1985. Used by permission.

**Further modified to include enhancements to QUAL2E resulting in Version 3.0 of the model, January 1987.

B. Data Type 1 - Program Control

Type 1 Data define the program control options and the characteristics of the stream system configuration, as well as some of the geographical/meteorological conditions for modeling temperature. There are a maximum of 17 Data 1 cards. The first 13 are required; the last four are necessary only if temperature is being simulated.

The QUAL2E program recognizes Type 1 Data by comparing the first four characters (columns 1-4) of each data card with a set of internally fixed codes. If a match between the code and characters occurs, then the data are accepted as supplied on the card by the user. If a match does not occur, then the program control options will revert to default values and the system variables for the unmatched codes will be assigned a value of zero (0.0).

The first seven cards control program options. If any characteristics <u>other</u> than those shown below are inserted in the columns 1 through 4, the actions described will <u>not</u> occur.

LIST - Card 1, list the input data.

WRIT - Card 2, write the intermediate output report, WRPT2 (see SUBROUTINE WRPT2 in the QUAL-II documentation report (Roesner et al., 1981), or NCASI Technical Bulletin No. 391).

FLOW - Card 3, use the flow augmentation option.

STEA - Card 4 shows this is a steady-state simulation. If it is <u>not</u> to be a steady-state, write DYNAMIC SIMULATION or NO STEADY STATE, and it is automatically a dynamic simulation.

TRAP - Card 5, cross-sectional data will be specified for each reach. If discharge coefficients are to be used for velocity and depth computations, write DISCHARGE COEFFICIENTS, or NO TRAPEZOIDAL CHANNELS, beginning in column 1.

PRIN - Card 6, local climatological data specified for the basin simulation will appear in the final output listing.

PLOT - Card 7, dissolved oxygen and BOD will be plotted in final output listing.

The next two cards provide further program flags and coefficients. This information is supplied in two data fields per card; columns 26-35, and 71-80. Note that the character codes in columns 1-4 must occur as shown in order for the data to be accepted by the program.

FIXE - Card 8, specifies: (a) whether the downstream boundary water quality constituent concentrations are fixed (user specified), and (b) the value of the rate coefficient for converting input 5-day BOD to ultimate BOD. A value of 1.0 (or larger) in columns 26-35 specifies that the downstream boundary water quality constituent concentrations will be supplied in Data Types 13 and 13A. A value less than 1.0 (usually 0.0 or blank) in these columns means that the downstream boundary concentrations are not user specified. In this case, the concentrations in the most downstream element (Type 5) will be computed in the normal fashion using the zero gradient assumption (Section 5.4.3.2). The second value on this card, columns 71-80, is the rate coefficient for converting 5-day to ultimate BOD. It is used only when 5-day BOD is being modeled (Title Card 7). If the columns are left blank, the model uses a default value of 0.23 per day, base e. Note that this conversion factor is applied to all input BOD_5 forcing functions (headwaters, incremental flows, point loads, and the downstream boundary condition).

INPU - Card 9, specifies whether the input and/or output will be in metric or English units. The value of 1.0 (or larger) in card columns 26-35 specifies metric input. The value of 1.0 (or larger) in card column 71-80 specifies metric units for output. Any value less than 1.0 (usually 0.0 or blank) will specify English units.

The next four cards describe the stream system. There are two data fields per card, columns 26-35 and 71-80. The program restrictions on the maximum number of headwaters, junctions, point loads, and reaches are defined by PARAMETER statements in the Fortran code. These statements may be modified by the user to accommodate a particular computer system or QUAL2E simulation application. The values of the constraints in the code as distributed by EPA are:

Maximum number of headwaters	7
Maximum number of junctions	6
Maximum number of point loads	25
Maximum number of reaches	25
Maximum number of computational elements	250

NUMB - Card 10, defines the number of reaches into which the stream is segmented and the number of stream junctions (confluences) within the system.

NUM_ - Card 11 shows the number of headwater sources and the number of inputs or withdrawals within the system. The inputs can be small streams, wasteloads, etc. Withdrawals can be municipal water supplies, canals, etc. NOTE: Withdrawals must have a minus sign ahead of the flow in Data Type 11 and must be specified as withdrawals in Data Type 4 by setting IFLAG = 7 for that element. Note, the code for Card 11 is 'NUM_ ' (read: NUM space) to distinguish it from the code for Card 10, NUMB.

TIME - Card 12 contains the time step interval in hours and the length of the computational element in miles (kilometers). The time step interval is used only for a dynamic simulation, thus it may be omitted if the simulation is steady-state.

MAXI - Card 13 provides information with different meanings depending on whether a dynamic or a steady-state simulation is being performed. For a dynamic simulation, the maximum route time is specified in columns 26-35. This value represents the approximate time in hours required for a particle of water to travel from the most upstream point in the system to the most downstream point. The time increment in hours for intermediate summary reports of concentration profiles is specified in columns 71-80. For a steady-state simulation, the maximum number of iterations allowed for solution convergence is entered in columns 26-35. The value in columns 71-80 may be left blank because it is not required in the steady-state solution.

The next four cards provide geographical and meteorological information and are required only if temperature is being simulated. There are two data fields per card, columns 26-35 and 71-80. Note: the character codes in columns 1-4 must occur as shown in order for the data to be accepted by the program.

LATI - Card 14 contains the basin latitude and longitude and represent mean values in degrees for the basin.

STAN - Card 15 shows the standard meridian in degrees, and the day of the year the (Julian date) simulation is to begin.

EVAP - Card 16, specifies the evaporation coefficients. Typical values are AE = 6.8×10^{-4} ft/hr-in Hg and BE = 2.7×10^{-4} ft/hr-in Hg-mph of wind for English units input, or AE = 6.2×10^{-6} m/hr-mbar and BE = 5.5×10^{-6} m/hr-mbar-m/sec of wind for metric units input.

ELEV - Card 17 contains the mean basin elevation in feet (meters) above mean sea level, and the dust attenuation coefficient (unitless) for solar radiation. The dust attenuation coefficient generally ranges between zero and 0.13. Users may want to consult with local meteorologists for more appropriate values.

Note: If the reach variable climatology option (steady-state simulations only) is used, the elevation data and dust attentuation coefficient for each reach are supplied in Data Type 5A and the value supplied in Data Type 1A are overridden.

Data Type 1 must end with an ENDATA1 card.

C. Data Type 1A - Global Algal, Nitrogen, Phosphorus, and Light Parameters

These parameters and constants apply to the entire simulation and represent the kinetics of the algal, nutrient, and light interactions. It is important to note that proper use of all options in QUAL2E requires detailed knowledge of the algal growth kinetics appropriate for the water body being simulated.

These data cards are required only if algae, the nitrogen series (organic, ammonia, nitrite, and nitrate), or the phosphorus series (organic and dissolved) are to be simulated. Otherwise they may be omitted, except for the ENDATA1A card. Information is supplied in two data fields per card, columns 33-39 and 74-80. As with Type 1 Data, QUAL2E recognizes Type 1A Data by comparing the first characters (columns 1-4) of each card with a set of internally fixed codes. If a match between the codes and the characters occurs, then data are accepted as supplied on the card by the user. If a match does not occur, then the system variables for the unmatched codes will be assigned the value zero (0.0). Note: the spaces (under bars) are an integral (necessary) part of the four character code.

O_UP - Card 1 specifies the oxygen uptake per unit of ammonia oxidation, and oxygen uptake per unit of nitrite oxidation.

O_PR - Card 2 contains data on oxygen production per unit of algae growth, usually 1.6 mg O/mg A, with a range of 1.4 to 1.8. It also contains data on oxygen uptake per unit of algae respiration, usually 2.0mg O/mg A respired, with a range of 1.6 to 2.3.

N_CO - Card 3 concerns the nitrogen content and phosphorus content of algae in mg N or P per mg of algae. The fraction of algae biomass that is nitrogen is about 0.08 to 0.09, and the fraction of algae biomass that is phosphorus is about 0.012 to 0.015.

ALG_ - Card 4 specifies the growth and respiration rates of algae. The maximum specific growth rate has a range of 1.0 to 3.0 per day. The respiration value of 0.05 is for clean streams, while 0.2 is used where the N_E and P_2 concentrations are greater than twice the half saturation constants.

N_HA - Card 5 contains the nitrogen and phosphorus half saturation coefficients. The range of values for nitrogen is from 0.01 to 0.3 mg/L and for phosphorus the values typically range from 0.001 to 0.05 mg/L.

LIN_ - Card 6 contains the linear and nonlinear algal selfshading light extinction coefficients. The coefficients λ_1 and λ_2 are defined below.

λ_1 = linear algae self-shading coefficient
(1/ft)/(ug chla/L), or (1/m)/(ug chla/L)

λ_2 = nonlinear algae self-shading coefficient
(1/ft)/ug chla/L)$^{2/3}$, or, (1/m)/(ug chla/L)$^{2/3}$

These two self-shading coefficients are used with λ_o, the non-algal light extinction coefficient (Type 6B Data) in the general light extinction equation shown below:

$$\lambda = \lambda_0 + \lambda_1 \alpha_o A + \lambda_2 (\alpha_o A)^{2/3}$$

where λ is the total light extinction coefficient and A is the algae biomass concentration in mg A/L and α_o is the chlorophyll a to algae biomass ratio as ug chla/mg A. Appropriate selection of the values of λ_0, λ_1, and λ_2 allows a variety of light extinction relationships to be simulated as follows.

* No self-shading (Roesner et al, SEMCOG)

  $\lambda_1 = \lambda_2 = 0$

* Linear algal self-shading (JRB Assoc. Vermont)

  $\lambda_1 \neq 0 \quad \lambda_2 = 0$

* Nonlinear self-shading (Riley Eq., metric units)

  $\lambda_1 = 0.0088$

  $\lambda_2 = 0.054$

LIGH - Card 7 contains the solar light function option for computing the effects of light attenuation on the algal growth rate, and the light saturation coefficient. QUAL2E recognizes three different solar light function options. The light saturation coefficient is coupled to the selection of a light function, thus care must be exercised in specifying a consistent pair of values.

The depth integrated form of the three light functions and the corresponding definitions of the light saturation coefficient are given in Section 3.2.3.1, Eq. III-6a,b,c and outlined in the following table.

Light Function Option (Columns 33-39)	Light Saturation Coefficient* (Columns 74-80)
1 (Half Saturation)	Half Saturation Coefficient
2 (Smith's Function)	Light intensity corresponding to 71% of maximum growth rate
3 (Steele's Function)	Saturation Light Intensity

* Units of the Light Saturation Coefficient are as follows:
  English: BTU/ft^2-min and Metric: Langleys/min

Light Function Option 1 uses a Michaelis-Menton half saturation formulation for modeling the algal growth limiting effects of light (FL). It is the method used in the SEMCOG version of QUAL-2. Option 2 is similar to Michaelis-Menton, but uses a second order rather than first order light effect. Both options 1 and 2 are monotonically increasing functions of light intensity. Option 3 includes a photo-inhibition effect at high light intensities and has been reported in Bowie et al. (1985).

DAIL - Card 8, contains the light averaging option (columns 33-39) and the light averaging factor (columns 74-80). These values are used only in a steady-state simulation. The light averaging option allows the user to specify the manner in which the light attenuation factor is computed, from the available values of solar radiation. (See Section 3.2.3.2). A summary of these options is given below.

Option	Description
1	FL is computed from one daily average solar radiation value calculated in the steady-state temperature subroutine (HEATER).
2	FL is computed from one daily average solar radiation read from Data Type 1A.
3	FL is obtained by averaging the 24 hourly values of FL, that are computed from the 24 hourly values of solar radiation calculated in the steady-state temperature subroutine (HEATER).
4	FL is obtained by averaging the 24 hourly values of FL, that are computed from the 24 hourly values of solar radiation computed from the total daily solar radiation (Data Type 1A) and an assumed cosine function.

Note: that if options 1 or 3 are selected, temperature must be simulated.

The light averaging factor (columns 74-80) is used to make a single calculation using daylight average solar radiation (Option 1 or 2) agree with average of calculations using hourly solar radiation values (Option 3 or 4). The factor has been reported to vary from 0.85 to 1.00.

The selection of a daily (diurnal) light averaging option depends largely on the detail to which the user wishes to account for the diurnal variation in light intensity. Options 1 and 2 utilize a single calculation of FL based on an average daylight solar radiation value. Options 3 and 4 calculate hourly values of FL from hourly values of solar radiation and then average the hourly FL values to obtain the average daylight value. Options 1 and 3 use the solar radiation from the temperature heat balance routines (thus both algae and temperature simulations draw on the same source for solar radiation). Options 2 and 4 use the solar radiation value in Data Type 1A for the algae simulation. Thus either option 2 or 4 must be selected when algae are simulated and temperature is not. The light averaging factor is used to provide similarity in FL calculations between options 1 and 2 versus options 3 and 4. The solar radiation factor (Data Type 1A, card 11) specifies the fraction of the solar radiation computed in the heat balance that is photosynthetically active. It is used only with options 1 or 3.

In dynamic algae simulations, option 3 is used (default) unless temperature is not simulated, in which case solar radiation data are read in with the local climatology data.

NUMB - Card 9 contains the number of daylight hours (columns 33-39), and the total daily radiation (BTU/ft^2, or Langleys) (columns 74-80). This information is used if light averaging options 2 or 4 are specified for the simulation.

ALGY - Card 10 contains the light-nutrient option for computing the algae growth rate (columns 33-39), and the algal preference factor for ammonia nitrogen (columns 74-80). The light-nutrient interactions for computing algae growth rate are as follows (see also Section 3.2.2).

Option	Description
1	Multiplicative: (FL) * (FN) * (FP)
2	Limiting Nutrient: FL * [minimum (FN, FP)]
3	Harmonic Mean $\frac{FL * 2}{1/FN + 1/FP}$

Option 1 is the form used in QUAL-II SEMCOG, while option 2 is used in the revised META Systems Version of QUAL-II (JRB Associates, 1983). Option 3 is described by Scavia and Park (1976).

The algal preference factor for ammonia (columns 74-80) defines the relative preference of algae for ammonia and nitrate nitrogen (see also Section 3.3.2). The user defines this preference by specifying a decimal value between 0 and 1.0, for example:

Algal Preference Factor for Ammonia	Interpretation
0.0	Algae will use only nitrate for growth.
0.5	Algae will have equal preference for ammonia and nitrate.
1.0	Algae will use only ammonia for growth.

ALG/ - Card 11 contains the factor for converting the solar radiation value from the heat balance to the solar radiation value appropriate for the algae simulation (columns 33-39) and the value of the first order nitrification inhibition coefficient (columns 74-80).

The solar radiation factor specifies the fraction of the solar radiation computed in the heat balance (subroutine HEATER) that is photosynthetically active (i.e., used by algal cells for growth). It is required only in steady-state simulations when light averaging options 1 or 3 (Data Type 1A, card 8) are selected. A decimal value between 0 and 1.0 specifies the value of this fraction. Typically the value of this fraction is about 0.45 (Bannister, 1974).

The first order nitrification inhibition coefficient is the value of KNITRF in the following equation (see Section 3.3.5).

CORDO = 1.0 - exp (-KNITRF * DO)

where:

DO = dissolved oxygen concentration (mg/L), and
CORDO = correction factor applied to ammonia and nitrite oxidation rate coefficients.

The following table contains values of CORDO as a function of DO (row) and KNITRF (column).

DO	KNITRF					
(mg/L)	0.5	0.7	1.0	2.0	5.0	10.0
0.1	.05	.07	.10	.18	.39	.63
0.2	.10	.13	.18	.33	.63	.86
0.3	.14	.19	.26	.45	.78	.95
0.4	.18	.24	.33	.55	.86	.98
0.5	.22	.30	.39	.63	.92	.99
0.7	.30	.39	.50	.75	.97	1.00
1.0	.39	.50	.63	.86	.99	1.00
1.5	.53	.65	.78	.95	1.00	1.00
2.0	.63	.75	.86	.98	1.00	1.00
3.0	.78	.88	.95	1.00	1.00	1.00
4.0	.86	.94	.98	1.00	1.00	1.00
5.0	.92	.97	.99	1.00	1.00	1.00
7.0	.97	.99	1.00	1.00	1.00	1.00
10.0	.99	1.00	1.00	1.00	1.00	1.00

A value of 0.6 for KNITRF closely matches the inhibition formula tion in QUAL-TX (TWDB, 1984) while a value of 0.7 closely matches the data for the Thames Estuary (DSIR, 1964). The default value of KNITRF is 10.0, i.e., no inhibition of nitrification at low dissolved oxygen.

ENDA - The last card in Data Type 1A must be an ENDATA1A card, regardless of whether algae, nitrogen, or phosphorus are simulated.

D. Data Type 1B - Temperature Correction Factors

Several of the processes represented in QUAL2E are affected by temperature. The user may elect to input specific temperature correction factors. In the absence of such information, default values are used as noted in Table A-1. The user need supply only those values that are to be changed.

Data Type 1B information is supplied as follows:

Alphanumeric code for each temperature coefficient as noted in Table A-1:	Columns 10-17
User specified temperature coefficient	Columns 19-26

The last card in Data Type 1B must be an ENDATA1B card, regardless of whether any of the default values are modified.

TABLE A-1 DEFAULT THETA VALUES FOR QUAL2E

INDEX	RATE COEFFICIENT	DEFAULT VALUES SEMCOG	QUAL-2E	CODE
1	BOD Decay	1.047	1.047	BOD DECA
2	BOD Settling	-	1.024	BOD SETT
3	Reaeration	1.0159	1.024	OXY TRAN
4	SOD Uptake	-	1.060	SOD RATE
5	Organic N Decay	-	1.047	ORGN DEC
6	Organic N Settling	-	1.024	ORGN SET
7	Ammonia Decay	1.047	1.083	NH3 DECA
8	Ammonia Source	-	1.074	NH3 SRCE
9	Nitrite Decay	1.047	1.047	NO2 DECA
10	Organic P Decay	-	1.047	PORG DEC
11	Organic P Settling	-	1.024	PORG SET
12	Dissolved P Source	-	1.074	DISP SRC
13	Algae Growth	1.047	1.047	ALG GROW
14	Algae Respiration	1.047	1.047	ALG RESP
15	Algae Settling	-	1.024	ALG SETT
16	Coliform Decay	1.047	1.047	COLI DEC
17	Non-cons Decay	1.047	1.000	ANC DECA
18	Non-cons Settling	-	1.024	ANC SETT
19	Non-cons Source	-	1.000	ANC SRCE

E. Data Type 2 - Reach Identification and River Mile/Kilometer Data

The cards of this group identify the stream reach system by name and river mile/kilometer by listing the stream reaches from the most upstream point in the system to the most downstream point. When a junction is reached, the order is continued from the upstream point of the tributary. There is one card per reach. The following information is on each card:

Reach Order or Number	Columns 16-20
Reach Identification or Name	Columns 26-40
River Mile/Kilometer at Head of Reach	Columns 51-60
River Mile/Kilometer at End of Reach	Columns 71-80

A very useful feature of QUAL2E pertaining to modifications of reach identification once the system has been coded is that existing reaches may be subdivided (or new reaches added) without renumbering the reaches for the whole system. If, for example, it is desired to divide the river reach originally designated as REACH 3 into two reaches, the division is made by calling the upstream portion REACH 3 and the "new reach" downstream REACH 3.1. Up to nine such divisions can be made per reach (3.1-3.9); thus REACH 3 (or any other reach) can be divided into as many as 10 reaches numbered 3, 3.1-3.9. This option of dividing a reach is useful particularly when new field data indicate a previously unknown change in geomorphology, or when the addition of a new or proposed load alters the biochemistry in the downstream portion of the reach. If this option is invoked, the number of reaches specified in Data Type 1 must be changed to the new total number of reaches.

Note: It is important to realize that this option cannot be used to subdivide a reach into more (and thus smaller) computational elements, in an attempt to provide greater detail to the simulation. All computational elements must have the same length (as specified in Type 1 Data).

This option also will allow the user to add a new reach to the system; for example, taking a tributary that was initially modeled as a point source and changing it to a modeled reach (or reaches) in the basin. This type of modification adds a junction to the system and thus the junction information in Data Types 1, 4, and 9 must be modified accordingly.

This group of cards must end with ENDATA2.

F. Data Type 3 - Flow Augmentation Data

These cards, except ENDATA3, are required only if flow augmentation is to be used. The cards in this group contain data associated with determining flow augmentation requirements and available sources of flow augmentation. There must be as many cards in this group as in the reach identification group. The following information is on each card.

Reach Order or Number	Columns 26-30
Augmentation Sources (the number of headwater sources which are available for flow augmentation)	Columns 36-40
Target Level (minimum allowable dissolved oxygen concentration (mg/L) in this reach)	Columns 41-50
Order of Sources (order of available headwaters, starting at most upstream points	Columns 51-80

This card group must end with ENDATA3, even if no flow augmentation is desired.

G. Data Type 4 - Computational Elements Flag Field Data

This group of cards identifies each type of computational element in each reach. These data allow the proper form of the routing equations to be used by the program. There are seven element types allowed, they are listed below.

IFLAG	Type
1	Headwater source element.
2	Standard element, incremental inflow/ outflow only.
3	Element on mainstream immediately upstream of a junction.
4	Junction element.
5	Most downstream element.
6	Input (point source) element.
7	Withdrawal element.

Each card in this group (one for each reach), contains the following information:

Reach Order or Number	Columns 16-20
Number of Elements in the Reach	Columns 26-30
Element Type (these are the numbers, (IFLAG above), which identify each element by type).	Columns 41-80

Remember that once a system has been coded, reaches can be divided or new ones added without necessitating the renumbering of the entire system (see Data Type 2 - Reach Identification and River Mile/Kilometer Data for application and constraints). When this option is invoked, the element types and number of elements per reach for the affected reaches must be adjusted in Data Type 4 to reflect the changes.

This card group must end with ENDATA4.

H. Data Type 5 - Hydraulics Data

Two options are available to describe the hydraulic characteristics of the system. The first option utilizes a functional representation, whereas the second option utilizes a geometric representation. The option desired is specified in Data Type 1, card 5. The code "TRAPEZOIDAL" specifically denotes the geometric representation. Any other code, such as "NO TRAPEZOIDAL," or "DISCHARGE COEFFICIENTS," specifies the functional representation.

Note: With either option, the effect is global (for the entire system). This option is not reach variable.

If the first option is selected, velocity is calculated as $V = aQ^b$ and depth is found by $D = cQ^d$. Each card represents one reach and contains the values of a, b, c, and d, as described below.

Reach Order or Number	Columns 16-20
Dispersion Constant	Columns 23-30
a, coefficient for velocity	Columns 31-40
b, exponent for velocity	Columns 41-50
c, coefficient for depth	Columns 51-60
d, exponent for depth	Columns 61-70
Mannings "n" for reach (if not specified, the program default value is 0.02)	Columns 71-80

The dispersion constant is the value of K in the general expression relating the longitudinal dispersion coefficient to the depth of flow and shear velocity (See Section 2.4.3).

$$D_L = Kdu^*$$

where:

D_L = longitudinal dispersion coefficient, (ft^2/sec, m^2/day)

K = dispersion constant, dimensionless

d = mean depth of flow, (ft,m)

u^* = shear velocity, (ft/sec, m/sec) = $(gdS)^{1/2}$

g = gravitational constant (ft/sec^2, m/sec^2)

S = slope of the energy grade line (ft/ft, m/m)

Substitution of the Manning equation for S leads to the following expression for the longitudinal dispersion coefficient, D_L.

$$D_L = 3.82\ Knud^{5/6}$$

where:

n = Mannings roughness coefficient, and

V = Mean stream velocity (ft/sec, m/sec).

Typical values of K range from 6 to 6000. A value of 5.93 leads to the Elder equation for longitudinal dispersion, which is the one used in the SEMCOG version of QUAL-II.

The coefficients a, b, c, and d should be expressed to relate velocity depth and discharge units as follows.

System	Q	V	D
Metric	m^3/sec	m/sec	m
English	ft^3/sec	ft/sec	ft

If the second option is selected, each reach is represented as a trapezoidal channel. These data are also used to specify the trapezoidal cross-section (bottom width and side slope), the channel slope, and the Manning's "n" corresponding to the reach. The program computes the velocity and depth from these data using Manning's Equation and the Newton-Raphson (iteration) method.

One card must be prepared for each reach:

Reach Order or Number	Columns 16-20
Dispersion Constant, K	Columns 23-30
Side Slope 1 (run/rise; ft/ft, m/m)	Columns 31-40
Side Slope 2 (run/rise; ft/ft, m/m)	Columns 41-50
Bottom Width of Channel, (feet, meters)	Columns 51-60
Channel Slope (ft/ft, m/m)	Columns 61-70
Mannings "n" (Default - 0.020)	Columns 71-80

This group of data cards must end with an ENDATA5 card.

HA. Data Type 5A - Temperature and Local Climatology Data

This group of data supplies the reach variable air temperature and climatological information for steady-state water temperature simulation. If QUAL2E is to be used in the dynamic/diurnal mode, the air temperature and climatological inputs must be global constants and are supplied in a separate data file according to the format described in Section X.- Climatological Data. The data in this group consist of geographical and meteorological data required for performing the energy balance for heat transfer across the air-water interface.

There are three options in QUAL2E for providing the input variables for steady state temperature simulation.

Option 1: Reach Variable Temperature Inputs. In this option the user specifies explicitly the values of the temperature simulation inputs for all reaches in the system. One card (line of data) is necessary for each reach and contains the following information.

Reach Order or Number	Columns 16-20
Reach Elevation (ft,m)	Columns 25-31
Dust Attenuation Coefficient	Columns 32-38
Cloudiness, fraction in tenths of cloud cover	Columns 39-45
Dry Bulb Air Temperature (F, C)	Columns 46-52
Wet Bulb Temperature (F, C)	Columns 53-59
Barometric (atmospheric) Pressure (inches Hg, millibars)	Columns 60-66
Wind Speed (ft/sec, m/sec)	Columns 67-73

Option 2a: Global Values - Current Version of QUAL2E. With this option the user may specify a single value for each of the temperature simulation inputs and QUAL2E will assume that these values apply to all reaches in the system being modeled. The required input data for this option is the same as that for option 1, with the exception that only one line of data is necessary.

Option 2b: Global Values - Prior QUAL2E Versions. The current version of QUAL2E will accépt without modification input data files for steady-state temperature simulations from prior versions of QUAL2E. Because prior versions treated the temperature simulation inputs as global constants, so also will the current version. In this option the required temperature simulation inputs are supplied according to the specifications in Section X - Climatological Data.

Option 3: Reach Variable Temperature Inputs with Estimation of Pressure Variation with Elevation. In the case where reach variable temperature simulation inputs are desired, but atmospheric pressure values are either unknown or unavailable, QUAL2E has the capability of estimating the value of atmospheric pressure for each reach from its elevation and temperature. These estimates are computed from the ideal gas law integrated, at constant temperature and specific humidity, over the change in elevation relative to a datum (see Section 4.8). The input requirements for this option are the same as for option 1, with the exception that the value of atmospheric pressure is supplied for only one reach. This value serves as the datum or reference from which atmospheric pressures for the other reaches are estimated. If this option is used, the computed values of reach atmospheric pressure will appear in the QUAL2E echo-print of the input data.

Notes:

1. It is important to realize that the user does not explicitly specify whether options 1,2, or 3 for steady-state reach variable temperature simulation are to be used. Rather, QUAL2E examines the format in which the temperature/climatology input information are provided in the input data file, matches it with one of the options described above, and then proceeds with the appropriate computational strategy.

2. This data group (Data Type 5A) must end with ENDATA5A. If option 2b is to be used (input data files from prior versions of QUAL2E), this data type is eliminated entirely. Data Type 5A is also not allowed for dynamic/diurnal QUAL2E simulations.

3. Values for elevation and dust attenuation coefficient appear in two places, here in Data Type 5A and also in Data Type 1. The values in Data Type 5A are used with options 1, 2a, and 3 and always override those in Data Type 1. The values in Data Type 1 are used only in option 2b - input data files from prior versions of QUAL2E.

I. Type 6 - BOD and DO Reaction Rate Constants Data

This group of cards includes reach information on the BOD decay rate coefficient and settling rate, sediment oxygen demand, as well as the method of computing the reaeration coefficient. Eight options for reaeration coefficient calculation are available (see Section 3.6.2) and are listed below.

K2 OPT	Method
1	Read in values of K2.
2	Churchill.
3	O'Connor and Dobbins.
4	Owens, Edwards, and Gibbs.
5	Thackston and Krenkel.
6	Langbien and Durum.
7	Use equation $K2 = aQ^b$
8	Tsivoglou-Wallace.

One card is necessary for each reach, and contains the following information:

Reach Order or Number	Columns 16-20
BOD Decay Rate Coefficient (1/day)	Columns 21-28
BOD Removal Rate by Settling (1/day)	Columns 29-36
Sediment Oxygen Demand (g/ft^2-day, g/m^2-day)	Columns 37-44
Option for K2 (1-8, as above)	Columns 45-48
K2 (Option 1 only) Reaeration Coefficient, per day, base e, 20C	Columns 49-56
a, Coefficient for K2 (Option 7) or Coefficient for Tsivoglou (Option 8)	Columns 57-64
b, Exponent for K2 (Option 7) or Slope of the Energy Gradient, S_e, (Option 8)	Columns 65-72

The units of a and b vary depending on whether option 7 or 8 is used and on whether the input data are in English or Metric units, as follows:

Units of a:	English	Metric
Option 7 (Coefficient)	Consistent with flow in cfs	Consistent with flow in cms
Option 8 (Coefficient)	1/ft	1/m

Units of b:	English	Metric
Option 7 (Exponent)	Consistent with flow in cfs	Consistent with flow in cms
Option 8 (S_e)	Dimensionless	Dimensionless

For option 8 (Tsivoglou's option), the energy gradient, S_e need not be specified if a Manning "n" value was assigned under Hydraulic Data Type 5. S_e will be calculated from Manning's Equation using the wide channel approximation for hydraulic radius.

This group of cards must end with ENDATA6.

J. Data Type 6A - N and P Coefficients

This group of cards is required if algae, the nitrogen series (organic nitrogen, ammonia, nitrite, and nitrate), or the phosphorus series (organic and dissolved) are to be simulated. Otherwise, they may be omitted. Each card of this group, one for each reach, contains the following information:

Reach Order or Number	Columns 20-24
Rate Coefficient for Organic-N Hydrolysis (1/day)	Columns 25-31
Rate Coefficient for Organic-N Settling (1/day)	Columns 32-38
Rate Coefficient for Ammonia Oxidation (1/day)	Columns 39-45
Benthos Source Rate for Ammonia (mg/ft^2-day, mg/m^2-day)	Columns 46-52
Rate Coefficient for Nitrite Oxidation (1/day)	Columns 53-59
Rate Coefficient for Organic Phosphorus Decay (1/day)	Columns 60-66
Rate Coefficient for Organic Phosphorus Settling (1/day)	Columns 67-73
Benthos Source Rate for Dissolved Phosphorus (as P, mg/ft^2-day, mg/m^2-day)	Columns 74-80

Note that the benthos source rates are expressed per unit of bottom area. Other versions of QUAL-II use values per length of stream. To convert to the areal rate, divide the length value by the appropriate stream width.

This group of cards must end with ENDATA6A, even if algae, nitrogen, or phosphorus are not simulated.

K. Data Type 6B - Algae/Other Coefficients

This group of cards is required if algae, the nitrogen series, the phosphorus series, coliform, or the arbitrary non-conservative is to be simulated. Otherwise, they may be omitted. Each card of the group, one per reach, contains the following information:

Reach Order or Number	Columns 20-24
Chlorophyll a to Algae Ratio* (ug chla/mg algae)	Columns 25-31
Algal Settling Rate (ft/day, m/day)	Columns 32-38
Non-Algal Light Extinction** Coefficient (1/ft, 1/m)	Columns 39-45
Coliform Decay Coefficient (1/day)	Columns 46-52
Arbitrary Non-Conservative Decay Coefficient (1/day)	Columns 53-59
Arbitrary Non-Conservative Settling Coefficient (1/day)	Columns 60-66
Benthos Source Rate for Arbitrary Non-Conservative (mg/ft^2-day, mg/m^2-day)	Columns 67-73

* If not specified, the QUAL2E default value is 50 ug Chl-a/mg algae.

** If not specified, the QUAL2E default value is 0.01 ft^{-1} which corresponds approximately to the extinction coefficient for distilled water.

This group of cards must end with ENDATA6B, even if algae, nitrogen, phosphorus, coliform, or the arbitrary, non-conservative are not simulated.

L. Data Type 7 - Initial Conditions - 1

This card group, one card per reach, establishes the initial conditions of the system, with respect to temperature, dissolved oxygen concentration, BOD concentration, and conservative minerals. Initial conditions for temperature must always be specified whether it is simulated or not. The reasons for this requirement are: (a) when temperature is not simulated, the initial condition values are used to set the value of the temperature dependent rate constants; (b) for dynamic simulations the initial condition for temperature, and every other quality constituent to be simulated, defines the state of the system at time zero; and (c) for steady state simulations of temperature, an initial estimate of the temperature between 35 F and 135 F is required to properly initiate the heat balance computations. Specifying 68F or 20C for all reaches is a sufficient initial condition for the steady-state temperature simulation case. The information contained is as follows.

Reach Order or Number	Columns 20-24
Temperature (F or C)**	Columns 25-31
Dissolved Oxygen (mg/L)	Columns 32-38
BOD (mg/L)	Columns 39-45
Conservative Mineral I*	Columns 46-52
Conservative Mineral II*	Columns 53-59
Conservative Mineral III*	Columns 60-66
Arbitrary Non-Conservative*	Columns 67-73
Coliform (No./100 ml)	Columns 74-80

* - Units are those specified on the Title Card.

** - If not specified, the QUAL2E default value is 68 F, 20 C.

This group of cards must end with ENDATA7.

M. Data Type 7A - Initial Conditions - 2

This group of cards is required if algae, the nitrogen series, or the phosphorus series are to be simulated. The information is coded as follows:

Reach Order or Number	Columns 20-24
Chlorophyll *a* (ug/L)	Columns 25-31
Organic Nitrogen as N (mg/L)	Columns 32-38
Ammonia as N (mg/L)	Columns 39-45
Nitrite as N (mg/L)	Columns 46-52
Nitrate as N (mg/L)	Columns 53-59
Organic Phosphorus as P (mg/L)	Columns 60-66
Dissolved Phosphorus as P (mg/L)	Columns 67-73

This group of cards must end with ENDATA7A, even if algae, nitrogen, or phosphorus are not simulated.

N. Data Type 8 - Incremental Inflow - 1

This group of cards, one per reach, accounts for the additional flows into the system not represented by point source inflows or headwaters. These inflows, which are assumed to be uniformly distributed over the reach, are basically groundwater inflows and/or distributed surface runoff that can be assumed to be approximately constant through time.

An important new feature to QUAL2E is that incremental outflow along a reach may be modeled. This option is useful when field data show a decreasing flow rate in the downstream direction indicating a surface flow contribution to groundwater.

Each card, one for each reach, contains the following information:

Reach Order or Number	Columns 20-24
Incremental Inflow (cfs, m^3/sec) outflows are indicated with a minus "-" sign.	Columns 25-31
Temperature (F, C)	Columns 32-38
Dissolved Oxygen (mg/L)	Columns 39-44
BOD (mg/L)	Columns 45-50
Conservative Mineral I	Columns 51-56
Conservative Mineral II	Columns 57-62
Conservative Mineral III	Columns 63-68
Arbitrary Non-Conservative	Columns 69-74
Coliform (No./100 ml)	Columns 75-80

This group of cards must end with ENDATA8.

O. Data Type 8A - Incremental Inflow - 2

This group of cards is a continuation of Data Type 8 and is required only if algae, the nitrogen series or the phosphorus series are to be simulated. Each card, one per reach, contains the following information.

Reach Order or Number	Columns 20-24
Chlorophyll a Concentration (ug/L)	Columns 25-31
Organic Nitrogen as N (mg/L)	Columns 32-38
Ammonia as N (mg/L)	Columns 39-45
Nitrite as N (mg/L)	Columns 46-52
Nitrate as N (mg/L)	Columns 53-59
Organic Phosphorus as P (mg/L)	Columns 60-66
Dissolved Phosphorus as P (mg/L)	Columns 67-73

This group of cards must end with ENDATA8A, even if algae, nitrogen, or phosphorus are not simulated.

P. Data Type 9 - Stream Junction Data

This group of cards is required if there are junctions or confluences in the stream being simulated. Otherwise, they may be omitted. The junctions are ordered starting with the most upstream junction. For systems containing a junction(s) on a tributary, the junctions must be ordered in the manner indicated in Figure A-1; that is, the junctions must be ordered so that the element numbers just downstream of the junction are specified in ascending order. In Figure A-1, the downstream element numbers for Junction 1, 2 and 3 are 29, 56, and 64, respectively. There is one card per junction, and the following information is on each card:

Junction Order or Number	Columns 21-25
Junction Names or Identification	Columns 35-50
Order Number of the Last Element in the reach immediately upstream of the junction (see Figure A-1). In the example, for Junction 1, the order number of the last element immediately upstream of the junction is number 17. For Junction 2, it is number 49. For Junction 3, it is number 43.	Columns 56-60
Order Number of the First Element in the reach immediately downstream from the junction. It is these numbers that must be arranged in ascending order. Thus, for Figure A-1 these order numbers for Junctions 1, 2, and 3 are 29,56, and 64 respectively.	Columns 66-70
Order Number of the Last Element in the last reach of the tributary entering the junction. For Figure A-1 these order numbers for Junctions 1, 2, and 3 are 28, 55, and 63, respectively.	Columns 76-80

This group of cards must end with ENDATA9, even if there are no junctions in the system.

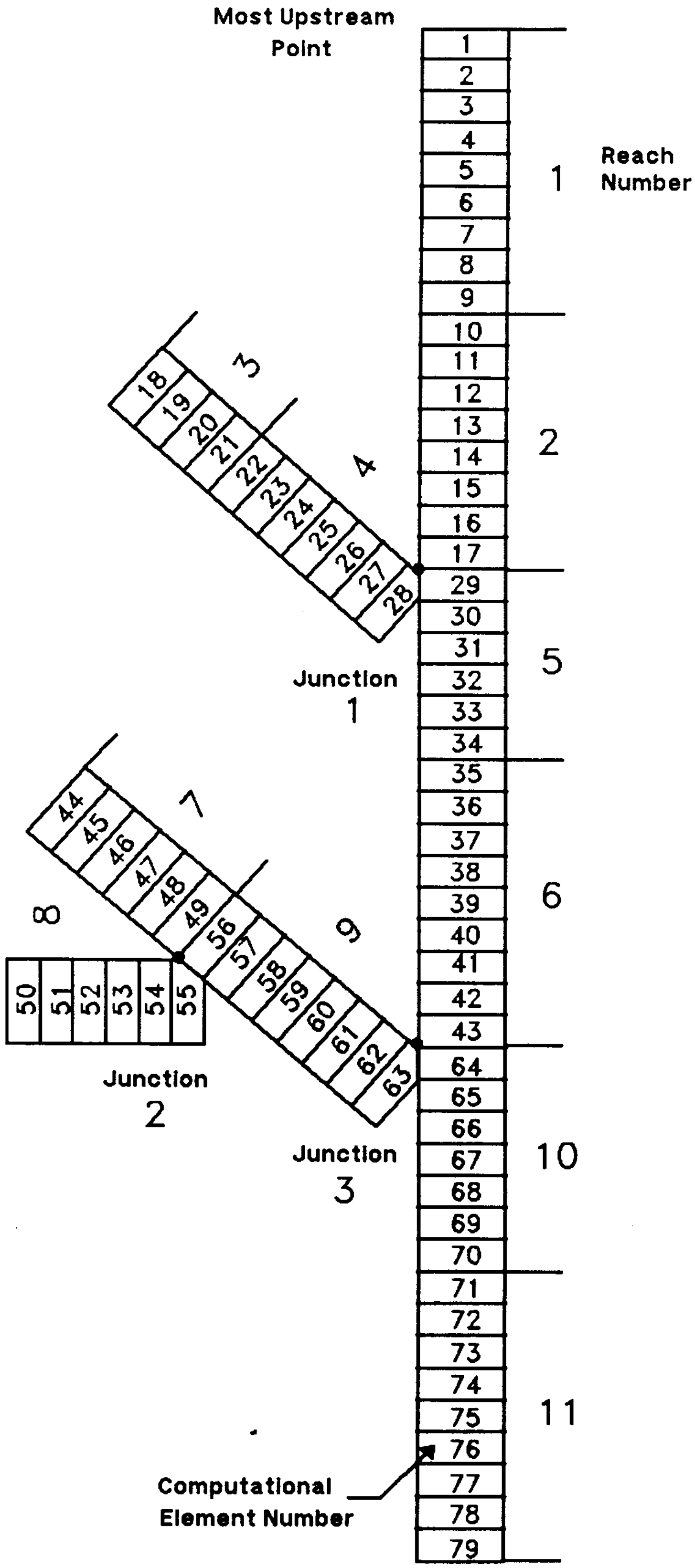

FIGURE A-1 STREAM NETWORK EXAMPLE TO ILLUSTRATE DATA INPUT

Q. Data Type 10 - Headwater Sources Data - 1

This group of cards, one per headwater, defines the flow, temperature, dissolved oxygen, BOD, and conservative mineral, concentrations of the headwater. The following information is on each card.

Headwater Order or Number Starting at Most Upstream Point	Columns 15-19
Headwater Name or Identification	Columns 20-35
Flow (cfs, m^3/sec)	Columns 36-44
Temperature (F, C)	Columns 45-50
Dissolved Oxygen Concentration (mg/L)	Columns 51-56
BOD Concentration (mg/L)	Columns 57-62
Conservative Mineral I	Columns 63-68
Conservative Mineral II	Columns 69-74
Conservative Mineral III	Columns 75-80

This group of cards must end with ENDATA10.

R. Data Type 10A - Headwater Sources Data - 2

This group of cards supplements the information in Data Type 10 and is required if algae, the nitrogen series, the phosphorus series, coliform, or arbitrary non-conservative are to be simulated. Each card, one per headwater, contains the following data.

Headwater Order or Number	Columns 16-20
Arbitrary Non-Conservative	Columns 21-26
Coliform, (No./100 ml)	Columns 27-32
Chlorophyll a (ug/L)	Columns 33-38
Organic Nitrogen as N (mg/L)	Columns 39-44
Ammonia as N (mg/L)	Columns 45-50
Nitrite as N (mg/L)	Columns 51-56
Nitrate as N (mg/L)	Columns 57-62
Organic Phosphorus as P (mg/L)	Columns 63-68
Dissolved Phosphorus as P (mg/L)	Columns 69-74

This group of cards must end with ENDATA10A, even if algae, nitrogen, phosphorus, coliform, or arbitrary non-conservative are not simulated.

S. Data Type 11 - Point Load - 1

This group of cards is used to define point source inputs and point withdrawals from the stream system. Point sources include both wasteloads and unsimulated tributary inflows. One card is required per inflow or withdrawal. Each card describes the percent of treatment (for wastewater treatment), inflow or withdrawal, temperature, and dissolved oxygen, BOD, and conservative mineral concentrations. They must be ordered starting at the most upstream point. The following information is on each card.

Point Load Order or Number	Columns 15-19
Point Load Identification or Name	Columns 20-31
Percent Treatment (applies only to influent BOD values)	Columns 32-36
Point Load Inflow or Withdrawal (cfs, m^3/sec) (a withdrawal must have a minus ("-") sign	Columns 37-44
Temperature (F, C)	Columns 45-50
Dissolved Oxygen Concentration (mg/L)	Columns 51-56
BOD Concentration (mg/L)	Columns 57-62
Conservative Mineral I	Columns 63-68
Conservative Mineral II	Columns 69-74
Conservative Mineral III	Columns 75-80

This group of cards must end with ENDATA11.

T. Data Type 11A - Point Load - 2

This group of cards supplements Data Type 11 and contains the algal, nutrient, coliform, and arbitrary non-conservative concentrations of the point source loads. This information is necessary only if algae, the nitrogen series, the phosphorus series, coliform, or the arbitrary non-conservative are to be simulated. Each card, one per waste load (withdrawal), contains the following information.

Point Load Order or Number	Columns 16-20
Arbitrary Non-Conservative	Columns 21-26
Coliform (No./100 ml)	Columns 27-32
Chlorophyll a (ug/L)	Columns 33-38
Organic Nitrate as N (mg/L)	Columns 39-44
Ammonia as N (mg/L)	Columns 45-50
Nitrite as N (mg/L)	Columns 51-56
Nitrate as N (mg/L)	Columns 57-62
Organic Phosphorus as P (mg/L)	Columns 63-68
Dissolved Phosphorus as P (mg/L)	Columns 69-74

This group of cards must end with ENDATA11A, even if algae, nitrogen, phosphorus, coliform, or arbitrary non-conservative are not simulated.

U. Data Type 12 - Dam Reaeration

This group of cards is required if oxygen input from reaeration over dams is to be modeled as a component of the dissolved oxygen simulation. Dam reaeration effects are estimated from the empirical equation attributed to Gameson as reported by Butts and Evans, 1983 (see Section 3.6.5). The following inputs are required.

Dam Order or Number	Columns 20-24
Reach Number of Dam	Columns 25-30
Element Number Below Dam	Columns 31-36
ADAM Coefficient: ADAM = 1.80 for clean water = 1.60 for slightly polluted water = 1.00 for moderately polluted water = 0.65 for grossly polluted water	Columns 37-42
BDAM Coefficient: BDAM = 0.70 to 0.90 for flat broad crested weir. = 1.05 for sharp crested weir with straight slope face. = 0.80 for sharp crested weir with vertical face. = 0.05 for sluice gates with submerged dishcarge.	Columns 43-48
Percent of Flow Over Dam (as a fraction 0.0-1.0)	Columns 49-54
Height of Dam (ft, m)	Columns 55-60

This group of cards must end with ENDATA12, even if oxygen input from dam reaeration is not to be modeled.

V. Data Type 13 - Downstream Boundary - 1

This data card supplies the constituent concentrations at the downstream boundary of the system. It is required only if specified in Data Type 1, card 8. This feature of QUAL2E is useful in modeling systems with large dispersion in the lower reaches (e.g., estuaries). When downstream boundary concentrations are supplied, the solution generated by QUAL2E will be constrained by this boundary condition. If the concentrations are not provided, the constituent concentrations in the most downstream element will be computed in the normal fashion using the zero gradient assumption (see Section 5.4.3.2).

Downstream boundary values for temperature, dissolved oxygen, BOD, conservative mineral, coliform, and arbitrary non-conservative are required as follows.

Temperature (F, C)	**Columns 25-31**
Dissolved Oxygen (mg/L)	**Columns 32-38**
BOD Concentration (mg/L)	**Columns 39-45**
Conservative Mineral I	**Columns 46-52**
Conservative Mineral II	**Columns 53-59**
Conservative Mineral III	**Columns 60-66**
Arbitrary Non-Conservative	**Columns 67-73**
Coliform (No./100 ml)	**Columns 74-80**

This data group must end with an ENDATA13 card, even if the fixed downstream boundary concentration option is not used in the simulation.

W. Data Type 13A - Downstream Boundary - 2

This group of data (one card) is a continuation of Data Type 13. It is required only if the fixed downstream boundary condition is used and if algae, the nitrogen series, and the phosphorus series are to be simulated. This card contains the downstream boundary concentrations for algae, nitrogen, and phosphorus as follows.

Chlorophyll *a* (ug/L)	Columns 25-31
Organic Nitrogen as N (mg/L)	Columns 32-38
Ammonia as N (mg/L)	Columns 39-45
Nitrite as N (mg/L)	Columns 46-52
Nitrate as N (mg/L)	Columns 53-59
Organic Phosphorus as P (mg/L)	Columns 60-66
Dissolved Phosphorus as P (mg/L)	Columns 67-73

This data group must end with an ENDATA13A card, even if the fixed downstream boundary condition is not used, and if algae, nitrogen, or phosphorus are not simulated.

X. Climatological Data

Climatological data are required for:

1. Temperature simulations, both steady-state and dynamic,
2. Dynamic simulations where algae is being simulated, and temperature is not.

If neither temperature nor dynamic algae are being simulated, these cards may be omitted.

For steady-state temperature simulations, these data may be supplied here (as in prior versions of QUAL2E) or in Data Type 5A, but not both. If the data are provided at this point in the input file, QUAL2E assumes that the climatological inputs are global constants. Only one card (line of data) is required, which gives the basin average values of climatological data, as follows.

Month	Columns 18-19
Day	Columns 21-22
Year (last two digits)	Columns 24-25
Hour of Day	Columns 26-30
Net Solar Radiation* (BTU/ft^2-hr, Langleys/hour)	Columns 31-40
Cloudiness**, fraction in tenths of cloud cover	Columns 41-48
Dry Bulb Temperature** (F, C)	Columns 49-56
Wet Bulb Temperature** (F, C)	Columns 57-64
Barometric pressure** (inches Hg, millibars)	Columns 65-72
Wind speed** (ft/sec, m/sec)	Columns 73-80

* Required only if dynamic algae is simulated and temperature is not.

** Required if temperature is simulated.

For dynamic/diurnal simulations, the climatological input data must be read from a separate input file (FORTRAN Unit Number 2). This input procedure is different from that used with prior versions of QUAL-II and QUAL2E and is designed to assist user interaction with QUAL2E by modularizing the variety of input data QUAL2E may require. The time variable climatology input data file is structured in the following manner. The first line consists of a descriptive title (80 alphanumeric characters) that identifies the data contained in the file. Subsequent lines provide the time variable basin average climatology data, chronologically ordered at 3-hour intervals. There must be a sufficient number of lines of data to cover the time period specified for the simulation (Data Type 1, card 13, MAXIMUM ROUTE TIME). The format for these data is the same as that described above for steady state temperature simulations.

There is no ENDATA line required for the climatological data.

Y. Plot Reach Data

This data type is required if the plotting option for DO/BOD is selected (Data Type 1, card 7, PLOT DO/BOD). The following information is required for QUAL2E to produce a line printer plot.

1. Card 1 - BEGIN RCH

Reach number at which plot is to begin	Columns 11-15

2. Card 2 - PLOT RCH

a. Reach numbers in their input order (1, 2, 3..NREACH)	Columns 11-15 Columns 16-20 21-26
b. If a reach is not to be plotted, (i.e., a tributary) replace the reach number with a zero.	etc. 76-80
c. Use additional PLOT RCH cards if there are more than 14 reaches in the system.	

3. Additional plots can be obtained by repeating the sequence of BEGIN RCH and PLOT RCH cards.

As an example of the plotting option, suppose that for the river system shown in Figure A-1, one wishes to obtain two DO/BOD plots: one for the main stream (Reaches 1, 2, 5, 6, 10, and 11) and one for the second tributary (Reaches 7 and 9). The plot data would appear in the following order.

```
BEGIN RCH 1
PLOT RCH 1  2  0  0  5  6  0  0  0  10  11
BEGIN RCH 7
PLOT RCH 0  0  0  0  0  0  7  0  9  0  0
```

No ENDATA card is required for the PLOT information.

YA. Plot Observed Dissolved Oxygen Data. The current version of QUAL2E has the capability to plot observed values of dissolved oxygen concentrations on the line printer plots produced for the computed values from the model. This feature is useful in assisting the user in model calibration. The observed DO data are read from a separate input data file (FORTRAN unit number 2) structured in a manner to be compatible with the Plot Reach Data (Section Y).

The first line, "DO TITLE:", consists of a descriptive title (70 alphanumeric characters) that identifies the data contained in the file. The second line, "NUM LOCS:", specifies the number of locations (n_1) for the first plot for which observed DO data are available. The next n_1 lines, "DO DATA", provide the observed DO data plotting information. One line is required for each location and contains the following data.

River location (mi, km)	Columns 11-20
Minimum DO (mg/L)	Columns 21-30
Average DO (mg/L)	Columns 31-40
Maximum DO (mg/L)	Columns 41-50

If only a single value of DO is available at a given location, it may be entered in either the minimum or average data position. Then by default, QUAL2E will set the minimum, maximum, and average values all equal to the value entered. When more than one line printer plot is specified in the Plot Reach Data, the observed DO values for these plots are provided on the lines following that for the first plot. The information is entered by repeating the sequence of "NUM LOCS:" and "DO DATA" lines for the data in the current plot.

Z. Summary

Constructing a consistent and correct input data set for a QUAL2E simulation must be done with care. This user's guide is designed to assist the user in this process. It has been NCASI's and EPA's experience that two of the most frequently made errors in constructing a QUAL2E input data set are:

(a) Usinga numerical value that is inconsistent with the input units option selected, and

(b) Notadheringto the 4-character input codes forData Types 1 and 1A.

As an aid to the units problem, Table A-2 is included in this report. It provides a complete summary of all the input variables whose dimensions are dependent on whether English or metric units are selected. Finally, the user is encouraged to check and recheck the input codes in Data Types 1 and 1A for accuracy, especially the codes for cards 10 and 11 of Data Type 1 (i.e., "NUMB" and "NUM_").

TABLE A-2. LIST OF QUAL2E INPUT VARIABLES THAT ARE ENGLISH/METRIC UNIT DEPENDENT

Data Type	Card or Line	Variable Description	FORTRAN Code Name	Units English	Units Metric
1	8	Input Units Specification	METRIC	0	1
	8	Output Units Specification	METOUT	0	1
1	11	Length of Computational Element	DELX	mile	kilometer
1	15	Evaporation Coefficient	AE	ft/hr-in Hg	m/hr-mbar
	15	Evaporation Coefficient	BE	ft/hr-in Hg-mph	m/hr-mbar-m/sec
1	16	Basin Elevation	ELEV	ft	meters
1A	6	Linear Algal Extinction Coeff	EXALG1	1/ft-ug-Chla/L	1/m-ug-Chla/L
	6	Non-linear Algal Extinction Coefficient	EXALG2	$1/ft\text{-}(ug\text{-}Chla/L)^{2/3}$	$1/m\text{-}(ug\text{-}Chla/L)^{2/3}$
1A	7	Light Saturation Coefficient	CKL	BTu/ft^2-min	langley/min
1A	9	Total Daily Solar Radiation	SONET	Btu/ft^2	langleys
2	all	River Mile/km to Head of Reach	RMTHOR	mile	kilometer
	all	River Mile/km to End of Reach	RMTEOR	mile	kilometer
5 (Discharge Coefficient)	all	Coefficient on Flow for Velocity Exponent on Flow for Velocity Coefficient on Flow for Depth Exponent on Flow for Depth	COEFQV EXPOQV COEFQH EXPOQH	Consistent with flow, velocity and depth in cfs, fps, ft respectively	Consistent with flow, velocity, and depth in cms, mps, m respectively
5 (Trapezoidal)	all	Bottom Width of Channel	WIDTH	ft	meters
5A	all	Reach Elevation	RCHELV	ft	meters
		Dry Bulb Temperature	RCHTDB	F	C
		Wet Bulb Temperature	RCHTWB	F	C
		Barometric Pressure	RCHATM	in Hg	mbar
		Wind Speed	RCHWND	ft/sec	m/sec
6	all	SOD Rate	CK4	gm/ft^2-day	gm/m^2-day
6	all	Option 7 for k_2 Coefficient on flow for k_2 Exponent on flow for k_2	COEQK2 EXPQK2	Consistent with flow in cfs	Consistent with flow in cms
6	all	Option 8 for K_2			
		Coefficient for Tsivoglou Eq.	COEQK2	1/ft	1/meter
		Slope of Energy Gradient	EXPQK2	ft/ft	meter/meter
6A	all	Benthal Source Rate for Ammonia-N	SNH3	mg/ft^2-day	mg/m^2-day
		Benthal Source Rate for Phosphorus	SPHOS	mg/ft^2-day	mg/m^2-day
6B	all	Algal Settling Rate	ALGSET	ft/day	m/day
		Non-algal Extinction Coefficient	EXCOEF	1/ft	1/meter
		Arbitrary Nonconservative Benthal Source Rate	SRCANC	mg/ft^2-day	mg/m^2-day
7	all	Initial Condition - Temperature	TINIT	F	C
8	all	Incremental Inflow			
		Flow Rate	QI	cfs	cms
		Temperature	TI	F	C
10	all	Headwater Conditions			
		Flow Rate	HWFLOW	cfs	cms
		Temperature	HWTEMP	F	C
11	all	Point Source/Withdrawal			
		Flow Rate	WSFLOW	cfs	cms
		Temperature	WFTEMP	F	C
12	all	Height of Dam	HDAM	ft	meters
13	1	Downstream Boundary-Temperature	LBTEMP	F	C
LCD	all	Solar Radiation	SOLHR	BTu/ft^2-hr	langleys/hr
		Dry Bulb Temperature	DRYBLB	F	C
		Wet Bulb Temperature	WETBLB	F	C
		Barometric Pressure	ATMPR	in Hg	mbar
		Wind Speed	WIND	ft/sec	m/sec

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (1) of (24)

TITLE DATA

CARD TYPE (cols 1–9)	SIMULATE YES/NO (cols 10–12)	ALPHANUMERIC NAME (cols 22–)	PARAMETER NAME	UNITS
TITLE01		TITLE OF RUN		
TITLE02		NAME OF BASIN		
TITLE03		CONSERVATIVE MINERAL I		
TITLE04		CONSERVATIVE MINERAL II		
TITLE05		CONSERVATIVE MINERAL III		
TITLE06		TEMPERATURE		
TITLE07		BIOCHEMICAL OXYGEN DEMAND		
TITLE08		ALGAE AS CHL-A IN UG/L		
TITLE09		PHOSPHORUS CYCLE AS P IN MG/L		
TITLE10		(ORGANIC-P; DISSOLVED-P)		
TITLE11		NITROGEN CYCLE AS N IN MG/L		
TITLE12		(ORGANIC-N; AMMONIA-N; NITRITE-N; NITRITE-N)		
TITLE13		DISSOLVED OXYGEN IN MG/L		
TITLE14		FECAL COLIFORMS IN NO./100 ML		
TITLE15		ARBITRARY NON-CONSERVATIVE		
ENDTITLE				

FORMAT (20A4)

NOTE: The nitrogen cycle variables and the phosphorus cycle variables must each be simulated, as a group.

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (2) of (24)

DATA TYPE 1 PROGRAM CONTROL DATA

	PROGRAM CONTROL PARAMETER	VALUE		PROGRAM CONTROL PARAMETER	VALUE
	LIST DATA INPUT				
	WRITE OPTIONAL SUMMARY				
	NO FLOW AUGMENTATION				
	STEADY STATE				
	NO TRAPEZOIDAL X-SECTIONS				
	PRINT SOLAR/LCD DATA				
	PLOT DO AND BOD				
	FIXED DNSTM CONC (YES=1) =			5D-ULT BOD CONV K COEF =	
	INPUT METRIC (YES=1) =			OUTPUT METRIC (YES=1) =	
	NUMBER OF REACHES =			NUMBER OF JUNCTIONS =	
	NUM OF HEADWATERS =			NUMBER OF POINT LOADS =	
	TIME STEP (HOURS) =			LNTH COMP ELEMENT (DX) =	
	MAXIMUM ITERATIONS =			TIME INC. FOR RPT2 (HRS) =	
*	LATITUDE OF BASIN (DEG) =			LONGITUDE OF BASIN (DEG) =	
*	STANDARD MERIDIAN (DEG) =			DAY OF YEAR START TIME =	
*	EVAP. COEFF. (AE) =			EVAP. COEF. (BE) =	
*	ELEV. OF BASIN (ELEV) =			DUST ATTENUATION COEF. =	
	ENDATA1				

FORMAT (6A4, A1, F10.0, 10X, 6A4, A1, F10.0)

* These lines may be omitted if temperature is not simulated.

PARAMETER	ENGLISH UNITS	METRIC UNITS
Length of Computational Element	miles	kilometers
Evaporation Coef. AE	(ft/hr)/(in-Hg)	(m/hr)/millibar
Evaporation Coef. BE	(ft/hr)/(in-Hg-mi/hr)	(m/hr)/(mbar-m/sec)
Elevation of Basin	feet	meters

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (3) of (24)

DATA TYPE 1A GLOBAL A, N, AND P PARAMETERS*

PARAMETER (1–32)	VALUE (33–39)	(40–41)	PARAMETER (42–73)	VALUE (74–)
O UPTAKE BY NH3 OXID(MG O/MG N)=			O UPTAKE BY NO2 OXID(MG O/MG N)=	
O PROD BY ALGAE (MG O/MG A)=			O UPTAKE BY ALGAE (MG O/MG A)=	
N CONTENT OF ALGAE (MG N/MG A)=			P CONTENT OF ALGAE (MG P/MG A)=	
ALG MAX SPEC GROWTH RATE(1/DAY)=			ALGAE RESPIRATION RATE (1/DAY)=	
N HALF SATURATION CONST (MG/L)=			P HALF SATURATION CONST (MG/L)=	
LIN ALG SHADE CO (1/H-UGCHA/L)=			NLIN SHADE (1/H-(UGCHA/L)**2/3)=	
LIGHT FUNCTION OPTION (LFNOPT)=			LIGHT SATURATION COEF (INT/MIN)=	
DAILY AVERAGING OPTION (LAVOPT)=			LIGHT AVERAGING FACTOR (AFACT)=	
NUMBER OF DAYLIGHT HOURS (DLH)=			TOTAL DAILY SOLAR RADTN (INT)=	
ALGY GROWTH CALC OPTION(LGROPT)=			ALGAL PREF FOR NH3-N (PREFN)=	
ALG/TEMP SOLR RAD FACTOR(TFACT)=			NITRIFICATION INHIBITION COEF=	
ENDATA1A				

FORMAT (8A4, F7.0, 2X, 8A4, F7.0)

*Data Type 1A information, except the ENDATA1A may be omitted unless algae, nitrogen, or phosphorus are to be simulated.

Units Notation: H = depth, INT = light intensity

PARAMETER	ENGLISH UNITS	METRIC UNITS
Linear Algae Self Shade Coef.	1/ft-ugChla/L	1/m-ugChla/L
Nonlinear Algae Self Shade Coef.	$1/ft-(ugChla/L)^{2/3}$	1/m-(ugChla/L)
Light Saturation Coefficient (PAR)	Btu/ft^2-min	Langleys/min
Total Daily Solar Radiation (PAR)	Btu/ft^2	Langleys

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (4) of (24)

DATA TYPE 1B THETA VALUES

DATA TYPE		CODE		VALUE	
THETA					
THETA					
ENDATA1B					

FORMAT (2A4, 1X, 2A4, 1X, F8.0)

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (5) of (24)

DATA TYPE 2 REACH IDENTIFICATION DATA

DATA TYPE	REACH IDENTIFICATION: ORDER	REACH IDENTIFICATION: ALPHANUMERIC NAME		RIVER MI/KM AT HEAD OF REACH		RIVER MI/KM AT END OF REACH
1–15	16–20	21–40	41–50	51–60	61–69	70–80
STREAM REACH		RCH=	FROM		TO	
STREAM REACH		RCH=	FROM		TO	
ENDATA2						

FORMAT (3A4,3X,F5.0,5A4,3X,A4,3X,F10.0,4X,A2,4X,F10.0)

NOTE: Once data has been coded, reaches may be subdivided without having to renumber the whole system - see text for intructions.

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (6) of (24)

DATA TYPE 3 FLOW AUGMENTATION DATA

DATA TYPE	ORDER OF REACH		NO. OF AUGMENT SOURCES AVAIL.	TARGET LEVEL DISSOLVED OXYGEN (MG/L)	ORDER OF AVAILABLE AUGMENTATION SOU				
					1st	2nd	3rd	4th	5th
1–25	26–30	31–35	36–40	41–50	51–55	56–60	61–65	66–70	71–75
FLOW AUGMT. SOURCES RCH=									
FLOW AUGMT SOURCES RCH=									
ENDATA3									

FORMAT (5A4, 5X, F5.0, 5X, F5.0, F10.0, 6F5.0)

These cards (except ENDATA3) may be deleted if flow augmentation is not used.

EPA / NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM 7 of 24

DATA TYPE 4 COMPUTATIONAL ELEMENT FLAG FIELD DATA

DATA TYPE (cols 1–15)	ORDER OF REACH (cols 16–20)	(cols 21–25)	NO. OF COMP. ELEM. (cols 26–30)	(cols 31–40)	COMPUTATIONAL ELEMENT FLAGS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 (cols 41–76)
FLAG FIELD RCH =					
FLAG FIELD RCH =					
ENDATA4					

FORMAT (2A4, A2, 5X, F5.0, 5X, F5.0, 10X, 20F2.0)

NOTE: If subdivision of reaches is necessary after initial system has been coded, it can be done without renumbering the entire system - see text under REACH INDENTIFICATION AND RIVER MI/KM DATA.

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (8) of (24)

DATA TYPE 5 HYDRAULIC DATA

TRAPAZOIDAL CHANNELS	ORDER OF REACH		DISPN CONST	SIDE SLOPE 1	SIDE SLOPE 2	WIDTH (FEET, METERS)	SLOPE	MANNING'S N
DISCHARGE COEFFICIENTS	ORDER OF REACH		DISPN CONST	COEF ON Q FOR VELOCITY	EXPO ON Q FOR VELOCITY	COEF ON Q FOR DEPTH	EXPO ON Q FOR DEPTH	MANNING'S N
1–15	16–20	21–22	23–30	31–40	41–50	51–60	61–70	71–80
HYDRAULICS RCH=								
HYDRAULICS RCH=								
ENDATA5								

FORMAT (2A4, A2, 5X, F5.0, 2X, F8.0, 5F10.0)

NOTE: The discharge coefficients must be expressed to relate flow, velocity, and depth units as follows:

VARIABLE	ENGLISH UNITS	METRIC UNITS
Flow	ft^3/sec	m^3/sec
Velocity	ft/sec	m/sec
Depth	ft	m

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

DATA TYPE 5A TEMPERATURE AND LOCAL CLIMATOLOGY DATA

FORM 8a of 24

DATA TYPE (1-15)	ORDER OF REACH (16-20)	(21-25)	ELEVATION (26-31)	DUST ATT'N COEF (32-38)	CLOUDINESS (39-45)	DRY BULB TEMP (46-52)	WET BULB TEMP (53-59)	BAROMETRIC PRESSURE (60-66)	WIND SPEED (67-73)	(not used) (74-80)
TEMP/LCD RCH=										
TEMP/LCD RCH=										
ENDATA5A										

FORMAT (2A4, A2, 5X, F5.0, 4X, 8F7.0)

VARIABLE	ENGLISH UNITS	METRIC UNITS
Elevation	ft	m
Drybulb, Wetbulb Temps	F	C
Barometric Pressure	in Hg	millibars
Wind Speed	ft/sec	m/sec

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (9) of (24)

DATA TYPE 6 BOD/DO COEFFICIENTS

DATA TYPE	ORDER OF REACH	BOD DEOX COEF (1/DAY)	BOD SETT COEF (1/DAY)	SOD * RATE	K2 OPT	REAERATION COEF (1/DAY)	*COEQK2 or TSIVG COEF FOR OPT 8	*EXPQK2 or SLOPE FOR OPT 8	(not used)
1–15	16–20	21–28	29–36	37–44	45–48	49–56	57–64	65–72	73–80
REACT COEF RCH=									
REACT COEF RCH=									
ENDATA6									

FORMAT (2A4, A2, 5X, F5.0, 3F8.0, F4.0, 3F8.0)

VARIABLE *	ENGLISH UNITS	METRIC UNITS
SOD Rate	gm/ft^2-day	gm/m^2-day
COEQK2, EXPQK2 (Opt. 7)	consistent with flow in ft^3/sec	consistent with flow in m^3/sec
TSIVG COEF (Opt. 8)	1/ft	1/m
SLOPE (Opt. 8)	ft/ft	m/m

EPA/NCASI STREAM QUALITY ROUTING MODEL — QUAL2E INPUT DATA CODING FORMS

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DATA TYPE 6A N AND P COEFFICIENTS

DATA TYPE	ORDER OF REACH	ORG-N HYDROLYSIS (1/DAY)	ORG-N SETT COEF (1/DAY)	NH-3 OXIDATION (1/DAY)	BENTHAL * SOURCE NH-3	NO-2 OXIDATION (1/DAY)	ORG-P DECAY (1/DAY)	ORG-P SETT COEF (1/DAY)	BENTH SOUR DIS
1–19	20–24	25–31	32–38	39–45	46–52	53–59	60–66	67–73	74–77
N AND P COEF RCH =									
N AND P COEF RCH =									
ENDATA6A									

FORMAT (3A4,A2,5X,F5.0,8F7.0)

VARIABLE *	ENGLISH UNITS	METRIC UNITS
Benthal Source for NH3-N	mg/ft^2-day	mg/m^2-day
Benthal Source for DIS-P	mg/ft^2-day	mg/m^2-day

EPA/NCASI STREAM QUALITY ROUTING MODEL — QUAL2E INPUT DATA CODING FORMS

DATA TYPE 6B ALGAE/OTHER COEFFICIENTS

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DATA TYPE (1–19)	ORDER OF REACH (20–24)	CHLA TO ALGAE RATIO (25–31)	*ALGY SETT RATE (32–38)	*NON ALGAL LIGHT EXT COEF. (39–45)	COLI DECAY (1/DAY) (46–52)	ANC DECAY (1/DAY) (53–59)	ANC-SETT COEF (1/DAY) (60–66)	* BENTHAL SOURCE ANC (67–73)	(not used) (74–80)
ALG/OTHER COEF RCH=									
ALG/OTHER COEF RCH=									
ENDATA6B									

FORMAT(3A4, A2, 5X, F5.0, 7F7.0)

* VARIABLE	ENGLISH UNITS	METRIC UNITS
Algal Settling Rate	ft/day	m/day
Non-algal Light Extinction Coef.	1/ft	1/m
Benthal Source for Arbitrary Non Cons.	mg-Anc/ft^2-day	mg-Anc/ft^2-day

FORM (12) of (24)

DATA TYPE 7 INITIAL CONDITIONS-1

DATA TYPE (1–19)	ORDER OF REACH (20–24)	TEMP (F, C) (25–31)	DISOLVED OXYGEN (MG/L) (32–38)	BOD (MG/L) (39–45)	CONS 1 (46–52)	CONS 2 (53–59)	CONS 3 (60–66)	ANC (67–73)	COLI (N 100 (74–76)
INITIAL COND-1 RCH=									
INITIAL COND-1 RCH=									
ENDATA7									

FORMAT(3A4, A2, 5X, F5.0, 8F7.0)

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (13) of (24)

DATA TYPE 7A INITIAL CONDITIONS-2

DATA TYPE	ORDER OF REACH	CHL-A (μG/L)	ORG-N (MG/L)	NH_3-N (MG/L)	NO_2-N (MG/L)	NO_3-N (MG/L)	ORG-P (MG/L)	DIS-P (MG/L)	(not us
1–19	20–24	25–31	32–38	39–45	46–52	53–59	60–66	67–73	74–77
INITIAL COND-2 RCH=									
INITIAL COND-2 RCH=									
ENDATA7A									

FORMAT (3A4, A2, 5X, F5.0, 7F7.0)

EPA/NCASI STREAM QUALITY ROUTING MODEL — QUAL2E INPUT DATA CODING FORMS

FORM (14) of (24)

DATA TYPE 8 INCREMENTAL FLOW 1

DATA TYPE	ORDER OF REACH	*INCREM. FLOW	*TEMP	DISSOLVED OXYGEN (MG/L)	BOD (MG/L)	CONS 1	CONS 2	CONS 3	ANC	COLIFORM (NO./100ML)
1–19	20–24	25–31	32–38	39–44	45–50	51–56	57–62	63–68	69–74	75–80
INCR INFLOW-1 RCH=										
INCR INFLOW-1 RCH=										
ENDATA8										

FORMAT (3A4, A2, 5X, F5.0, 2F7.0, 7F6.0)

*VARIABLE	ENGLISH UNITS	METRIC UNITS
Incremental Flow	ft^3/sec	m^3/sec
Temperature	F	C

EPA / NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (15) of (24)

DATA TYPE 8A INCREMENTAL FLOW - 2

DATA TYPE (cols 1–19)	ORDER OF REACH (cols 20–24)	CHL-A (µG/L) (cols 25–31)	ORG-N (MG/L) (cols 32–38)	NH3-N (MG/L) (cols 39–45)	NO2-N (MG/L) (cols 46–52)	NO3-N (MG/L) (cols 53–59)	ORG-P (MG/L) (cols 60–66)	DIS-P (MG/L) (cols 67–73)	(not used) (cols 74–80)
INCR INFLOW-2 RCH=									
INCR INFLOW-2 RCH=									
ENDATA8A									

FORMAT (3A4, A2, 5X, F5.0, 7F7.0)

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

DATA TYPE 9 STREAM JUNCTION DATA

FORM (16) of (24)

DATA TYPE	ORDER OF JUNCTION		JUNCTION IDENTIFICATION		ELEMENT TYPE: TYPE 3 NO. OF ELEMENT UPSTRM OF JUNC		ELEMENT TYPE: TYPE 4 NO. OF ELEMENT DNSTRM OF JUNC		ELEMENT TYPE: TYPE 2 NO. OF ELEMENT ON TRIB.
1–20	21–25	26–30	31–50	51–55	56–60	61–65	66–70	71–75	76–80
STREAM JUNCTION			JNC=						
STREAM JUNCTION			JNC=						
ENDATA9									

FORMAT (3A4, A3, 5X, F5.0, 5X, 5A4, 3(5X, F5.0)

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM (17) of (24)

DATA TYPE 10 HEADWATER-1

DATA TYPE (1–14)	ORDER OF HDW (15–19)	ALPHANUMERIC NAME (20–35)	HEADWATER FLOW* (36–44)	TEMP* (45–50)	DISSOLVED OXYGEN (MG/L) (51–56)	BOD (MG/L) (57–62)	CONS 1 (63–68)	CONS 2 (69–74)	CONS 3 (75–80)
HEADWTR-1 HDW=									
HEADWTR-1 HDW=									
ENDATA10									

FORMAT (2A4, A2, 4X, F5.0, 4A4, F9.0, 6F6.0)

*VARIABLE	ENGLISH UNITS	METRIC UNITS
Headwater Flow	ft^3/sec	m^3/sec
Temperature	F	C

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

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DATA TYPE 10A HEADWATER-2

DATA TYPE	ORDER OF HDW	ANC	COLI (NO./ 100 ML)	CHL-A (μG/L)	ORG-N (MG/L)	NH3-N (MG/L)	NO2-N (MG/L)	NO3-N (MG/L)	ORG-P (MG/L)	DIS-P (MG/L)	(not used)
1–15	16–20	21–26	27–32	33–38	39–44	45–50	51–56	57–62	63–68	69–74	75–80
HEADWTR-2 HDW=											
HEADWTR-2 HDW=											
ENDATA10A											

FORMAT (2A4, A2, 5X, F5.0, 9F6.0)

EPA/NCASI STREAM QUALITY ROUTING MODEL — QUAL2E INPUT DATA CODING FORMS

FORM (19) of (24)

DATA TYPE 11 POINT LOAD AND WITHDRAWAL-1

DATA TYPE	ORDER OF LOAD	ALPHANUMERIC NAME	% TREAT-MENT	INFLOW or WITHDRAWAL *	TEMP *	DISSOLVED OXYGEN (MG/L)	BOD (MG/L)	CONS 1	CONS 2	CON
1–14	15–19	20–31	32–36	37–44	45–50	51–56	57–62	63–68	69–74	75–77
POINTLD-1 PTL=										
POINTLD-1 PTL=										
ENDATA11										

FORMAT (2A4, A1, 5X, F5.0, 3A4, F5.0, F8.0, 6F6.0)

*VARIABLE	ENGLISH UNITS	METRIC UNITS
Inflow or withdrawal	ft^3/sec	m^3/sec
Temperature	F	C

EPA / NCASI STREAM QUALITY ROUTING MODEL — QUAL2E INPUT DATA CODING FORMS

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DATA TYPE 11A POINT LOAD AND WITHDRAWAL - 2

DATA TYPE	ORDER OF LOAD	ANC	COLI (NO./ 100 ML)	CHL-A (μG/L)	ORG-N (MG/L)	NH3-N (MG/L)	NO2-N (MG/L)	NO3-N (MG/L)	ORG-P (MG/L)	DIS-P (MG/L)	(not used)
1–15	16–20	21–26	27–32	33–38	39–44	45–50	51–56	57–62	63–68	69–74	75–80
POINTLD-2 PTL=											
POINTLD-2 PTL=											
ENDATA11A											

FORMAT (2A4, A2, 5X, F5.0, 9F6.0)

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

DATA TYPE 12 DAM REAERATION COEFFICIENTS

FORM (21) of (24)

DATA TYPE	DAM NO.	RCH. NO. OF DAM	ELE. NO. BELOW DAM	ADAM	BDAM	FRACTION FLOW OVER DAM FDAM	HEIGHT OF DAM HDAM (FT, M)	
1–19	20–24	25–30	31–36	37–42	43–48	49–54	55–60	61–80
DAM DATA DAM =								
DAM DATA DAM =								
ENDATA12								

FORMAT (3A4, A2,5X,F5.0,bF6.0)

EPA/NCASI STREAM QUALITY ROUTING MODEL – QUAL2E INPUT DATA CODING FORMS

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DATA TYPE 13 DOWNSTREAM BOUNDARY - 1

DATA TYPE (1–24)	TEMP (F,C) (25–31)	DISSOLVED OXYGEN (MG/L) (32–38)	BOD (MG/L) (39–45)	CONS 1 (46–52)	CONS 2 (53–59)	CONS 3 (60–66)	ANC (67–73)	COLIFORM (NO./100 ML) (74–80)
DOWNSTREAM BOUNDARY-1								
ENDATA13								

DATA TYPE 13A DOWNSTREAM BOUNDARY - 2

DATA TYPE (1–24)	CHL-A (μG/L) (25–31)	ORG-N (MG/L) (32–38)	NH3-N (MG/L) (39–45)	NO2-N (MG/L) (46–52)	NO3-N (MG/L) (53–59)	ORG-P (MG/L) (60–66)	DIS-P (MG/L) (67–73)	(not used) (74–80)
DOWNSTREAM BOUNDARY-2								
ENDATA13A								

FORMAT (6A4, 8F7.0)

EPA/NCASI STREAM QUALITY ROUTING MODEL – QUAL2E INPUT DATA CODING FORMS

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LOCAL CLIMATOLOGICAL DATA

DATA TYPE	MONTH, DAY AND YEAR	HOUR OF DAY	NET SOLAR RADIATION	CLOUDINESS	DRY BULB TEMP	WET BULB TEMP	BAROMETRIC PRESSURE	WIND SPE
1–17	18–25	26–30	31–40	41–48	49–56	57–64	65–72	73–78
LOCAL CLIMATOLOGY								
LOCAL CLIMATOLOGY								
1–17	18–25	26–30	31–40	41–48	49–56	57–64	65–72	73–78

* Must be chronologically ordered. FORMAT (30X, F10.0, 5F8.0)

Net solar radiation is not required if temperature is simulated, but is only required for dynamic algae simulation when temperature is not simulated.

VARIABLE	ENGLISH UNITS	METRIC UNITS
Net Solar Radiation (PAR)	BTU/ft^2-hr	Langleys/hr
Wetbulb, Drybulb Temps	F	C
Barometric Pressure	in Hg	millibars
Wind Speed	ft/sec	m/sec

NOTE: These data must appear in a separate input data file (FORTRAN unit number 2) if dynamic/diurnal temperature simulatio are being performed. See Section X - Climatological Data.

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT DATA CODING FORMS

FORM 24 of 24

DO AND BOD REACH PLOT DATA

DATA TYPE	REACH NUMBERS IN ORDER FOR PLOTTING 1	2	3	4	5	6	7	8	9	10	11	12	13	14
BEGIN RCH														
PLOT RCH														
BEGIN RCH														
PLOT RCH														

FORMAT (A4, 6X, I5); FORMAT (10X, 14I5)

BEGIN RCH = Id number of first reach in the plot.

PLOT RCH = Reach numbers in the proper order for plotting.

NOTE: Multiple plots are obtained by repeating the sequence of BEGIN RCH and PLOT RCH information (see User's Manual for example).

EPA/NCASI STREAM QUALITY ROUTING MODEL - QUAL2E INPUT CODING FORMS

Form 24A

PLOT OBSERVED DISSOLVED OXYGEN DATA

DATA TYPE (1–10)	RIVER LOCATION (MI/KM) (11–20)	MINIMUM DO (MG/L) (21–30)	AVERAGE DO (MG/L) (31–40)	MAXIMUM DO (MG/L) (41–50)	(51–80)
DO TITLE:					
NUM LOCS:					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
NUM LOCS:					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					
DO DATA					

FORMATS: DO TITLE: (20A4)
NUM LOCS: (10X,I4)
DO DATA: (10X,4F10.0)

Notes: Observed DO DATA for multiple plots are input by repeating the sequence of NUM LOCS: and DO DATA information. These data must appear in a separate data file (FORTRAN unit number 2) from the QUAL2E input data file.